What is claimed is:

1. A waveguide-type optical device comprising:

a substrate on which optical waveguides or optical fibers are provided and a trench for dividing optical paths of the optical waveguides or the optical fibers is formed;

a pair of electrodes which is assigned to each optical waveguide or optical fiber and is formed from the surface of the substrate at both sides of the trench to wall surfaces of the trench; and

a material or device which is filled or inserted into the trench, and which has one of an electro-optic effect, a thermo-optic effect, a light emitting function, a light receiving function, and a light modulating function.

2. A waveguide-type optical device as claimed in claim 1, wherein the electrodes are extended by attaching a flexible substrate or by wire bonding, and a voltage is applied to the material or device via the extended electrodes.

3. A waveguide-type optical device as claimed in claim 1, wherein the material or device which is filled or inserted into the trench is one of a nematic liquid crystal having an electro-optic effect, a cholesteric-nematic phase transition type liquid crystal, a polymer network liquid crystal, a polymer-dispersed liquid crystal, a polymer-stabilized liquid crystal, a dynamic scattering liquid crystal, and a ferroelectric liquid crystal.

4. A waveguide-type optical device as claimed in claim 1, wherein the material or device which is filled or inserted into the trench is a polymeric material having a

thermo-optic effect.

5. A waveguide-type optical device as claimed in claim 1, wherein the material or device which is filled or inserted into the trench is one of a surface-normal optical modulator, a surface light emitting device, and a surface-normal detector which has one of a light emitting function, a light receiving function, and a light modulating function.

6. A waveguide-type optical device as claimed in claim 3, wherein:

the material or device which is filled or inserted into the trench is the polymer-dispersed liquid crystal; and

the polymer-dispersed liquid crystal is one of a normal polymer-dispersed liquid crystal in which each particle has a diameter of 0.5 μm or more, and a nanosize droplet liquid crystal in which each particle has a diameter of 150 nm or less.

7. A manufacturing method of a waveguide-type optical device, comprising the steps of:

forming a trench on a substrate on which optical waveguides or optical fibers are provided, in a manner such that the trench divides optical paths of the optical waveguides or the optical fibers;

forming a pair of electrodes, which is assigned to each optical waveguide or optical fiber, from the surface of the substrate at both sides of the trench to wall surfaces of the trench; and

filling or inserting a material or device into the trench, which has one of an electro-optic effect, a thermo-optic effect, a light emitting function, a light receiving function, and a light modulating function.

8. A manufacturing method as claimed in claim 7, wherein the electrodes are formed by sputtering or vapor deposition.

9. A manufacturing method as claimed in claim 7, wherein the step of forming a pair of electrodes includes:

inserting a polymer material into the trench and selectively removing a portion of the polymer material; and

performing patterning of said pair of electrodes, which is separately assigned to each optical waveguide or optical fiber, on the wall surfaces of the trench by etching.

10. A manufacturing method as claimed in claim 7, wherein the step of forming a pair of electrodes includes:

patterning the electrodes on the wall surfaces of the trench by directly using a laser beam.

11. A manufacturing method as claimed in claim 7, wherein a liquid crystal is filled into the trench, and the filling step includes:

coating each wall surface of the trench with an alignment layer for the liquid crystal;

performing rubbing of the alignment layer by inserting a tape and pulling the tape in a single direction;

filling a polymer-stabilized liquid crystal into the trench;

performing alignment of the liquid crystal by irradiation of ultraviolet light while a magnetic field is applied to the liquid crystal.

12. A manufacturing method as claimed in claim 7, wherein a liquid crystal is filled into the trench, and the filling step includes:

coating each wall surface of the trench with a photo-alignment layer for the liquid crystal; and

performing alignment of the liquid crystal by irradiating the photo-alignment layer with first and second polarized ultraviolet light beams.

13. A manufacturing method as claimed in claim 7, wherein a liquid crystal is filled into the trench, and the filling step includes:

coating each wall surface of the trench with an alignment layer for the liquid crystal; and

performing alignment of the liquid crystal by irradiating the alignment layer with an ion beam.

14. A waveguide-type optical device comprising:

a substrate on which optical waveguides or optical fibers are provided and a trench for dividing optical paths of the optical waveguides or the optical fibers is formed;

a thin and surface-normal active optical device driven by an applied voltage, which is substantially vertically inserted into the trench and is fixed in the trench; and

a support member attached to the thin and surface-normal active optical device.

15. A waveguide-type optical device as claimed in claim 14, wherein for a given thickness w of the thin and surface-normal active optical device, width W of the trench

satisfies the condition "$w < W < 300\ \mu m$".

16. A waveguide-type optical device as claimed in claim 14, wherein electrodes are formed on the support member, which function as electrodes of the thin and surface-normal active optical device.

17. A waveguide-type optical device as claimed in claim 14, wherein:

the support member is one of a rectangular block, an L-shaped block, and a cylindrical block, and the block is made of one of glass, ceramics, and plastics; and

height h and width I of the block, and length s of a protruding portion of the thin and surface-normal active optical device, which protrudes from the block, have a relationship of "$I/h > s/I$" by which the thin and surface-normal active optical device does not fall when the device supported by the support member is put on the surface of the substrate in an inclined position.

18. A waveguide-type optical device as claimed in claim 16, wherein:

the thin and surface-normal active optical device has electrodes;

the support member is a rectangular block, and L-shaped electrodes are formed on the block in a manner such that the L-shaped electrodes lie on two adjacent faces of the block, where the faces include the top face of the block; and

the electrodes of the thin and surface-normal active optical device are respectively connected to the electrodes of the block attached to the device, thereby extending the electrodes of the device to the top face of the block.

19. A waveguide-type optical device as claimed in claim 14, wherein the thin and

surface-normal active optical device is one of:

a PbS optical detector formed on a glass plate or an a-Si optical detector;

an optical detector obtained by thinning a semiconductor device;

a semiconductor optical modulator;

a polarizer obtained by dispersing metal particles in glass, where the particles are aligned in the long particle axis;

a wavelength plate made of an optical crystal;

a dielectric multi-layered filter deposited on a glass plate;

an ND filter;

a variable-wavelength filter made by placing an electro-optic crystal or electro-optic ceramics between dielectric multi-layered mirrors; and

a polarization modulator having an electro-optic crystal or electro-optic ceramics.

20. A waveguide-type optical device as claimed in claim 14, wherein:

the thin and surface-normal active optical device is a liquid crystal device; and

the support member is a pair of blocks between which the liquid crystal device is placed,

wherein the liquid crystal device comprises:

thin glass plates which are respectively attached to faces of the blocks, where said faces of the blocks face each other via the liquid crystal device and a patterned electrode is formed on each glass plate;

an alignment layer formed on each thin glass plate, where the alignment layer is subjected to an alignment process such as rubbing; and

a liquid crystal filled into a space between the alignment layers of the thin glass

plates.

21. A waveguide-type optical device as claimed in claim 20, wherein:

the patterned electrode includes 8 electrodes having a radial and symmetric form with respect to a center portion surrounded by the 8 electrodes;

said center portion has a window having a diameter of 20 to 50 μm;

voltage applied to each of the 8 electrodes is controlled so as to apply an electric field, which has any desired power and is in any desired direction, to the center portion surrounded by the 8 electrodes; and

incident light having any polarization direction is converted into light having any desired polarization direction.

22. A waveguide-type optical device as claimed in claim 14, wherein:

the thin and surface-normal active optical device is a thin optical modulator which comprises:

a thin PLZT plate having four trenches dug from upper, lower, right, and left sides of the plate;

four electrodes formed from the above four sides of the PLZT plate to the inside of each trench;

a conductive adhesive with which each trench is filled; and

a thin glass plate attached to the PLZT plate, which has four electrodes to which the four electrodes of the PLZT plate are respectively connected, and

wherein the thin glass plate is attached and fixed to the support member in a manner such that light passes through a center portion between the four electrodes of the PLZT plate, and the electrodes of the thin glass plate function as external electrodes of

the optical modulator; and

voltage applied to each of the four electrodes is controlled so as to apply an electric field having any desired power and in any desired direction, thereby continuously and completely controlling the polarization direction of incident light into light having a linear polarization.

23. A waveguide-type optical device as claimed in claim 22, wherein the optical waveguides or optical fibers which are provided on the substrate are expanded core fibers.

24. A manufacturing method of a waveguide-type optical device, comprising the steps of:

forming a trench on a substrate on which optical waveguides or optical fibers are provided, in a manner such that the trench divides optical paths of the optical waveguides or the optical fibers;

attaching a support member to a thin and surface-normal active optical device which is driven by an applied voltage, in a manner such that a portion of the active optical device protrudes from the support member; and

substantially vertically inserting the protruding portion of the thin and surface-normal active optical device which is supported by the supported member into the trench and fixing the device in the trench.

25. A manufacturing method as claimed in claim 24, wherein for a given thickness w of the thin and surface-normal active optical device, width W of the trench satisfies the condition "$w < W < 300\ \mu m$".

26. A manufacturing method as claimed in claim 24, wherein:

a positioning mark is provided on the thin and surface-normal active optical device before the device is inserted into the trench to make a portion of the thin and surface-normal active optical device, through which light passes, coincide with a corresponding core of each optical waveguide or optical fiber, where the position of the positioning mark is away from the position of the portion through which light passes, by the distance from the surface of the substrate to the position of the core; and

the support member is attached to the thin and surface-normal active optical device in a manner such that the positioning mark coincides with the bottom face of the support member.

27. A manufacturing method as claimed in claim 24, wherein:

the support member is one of a rectangular block, an L-shaped block, and a cylindrical block, and the block is made of one of glass, ceramics, and plastics;

height h and width I of the block, and length s of a protruding portion of the thin and surface-normal active optical device, which protrudes from the block, have a relationship of "I/h > s/I"; and

the step of inserting the protruding portion of the thin and surface-normal active optical device includes the steps of:

putting the device supported by the support member on the surface of the substrate in an inclined position, so as to prevent the device from falling onto the substrate;

sliding the device on the surface of the substrate towards the trench; and

making the device fall into the trench and fixing the inserted device.

28. A manufacturing method as claimed in claim 27, wherein in the step of sliding the device on the surface of the substrate, both the support member and an end of the thin and surface-normal active optical device contact the surface of the substrate.

29. A manufacturing method as claimed in claim 27, wherein in the step of making the device fall into the trench, when the thin and surface-normal active optical device reaches the position of the trench, an end of the device contacts a wall surface of the trench and the thin and surface-normal optical device bends and falls into the trench.

30. A manufacturing method as claimed in claim 24, wherein:

the thin and surface-normal active optical device has electrodes; and

the support member is a rectangular block,

the method further comprising the steps of:

forming L-shaped electrodes on the block in a manner such that the L-shaped electrodes lie on two adjacent faces of the block, where the faces include the top face of the block; and

respectively connecting the electrodes of the thin and surface-normal active optical device to the electrodes of the block attached to the device, thereby extending the electrodes of the device to the top face of the block.